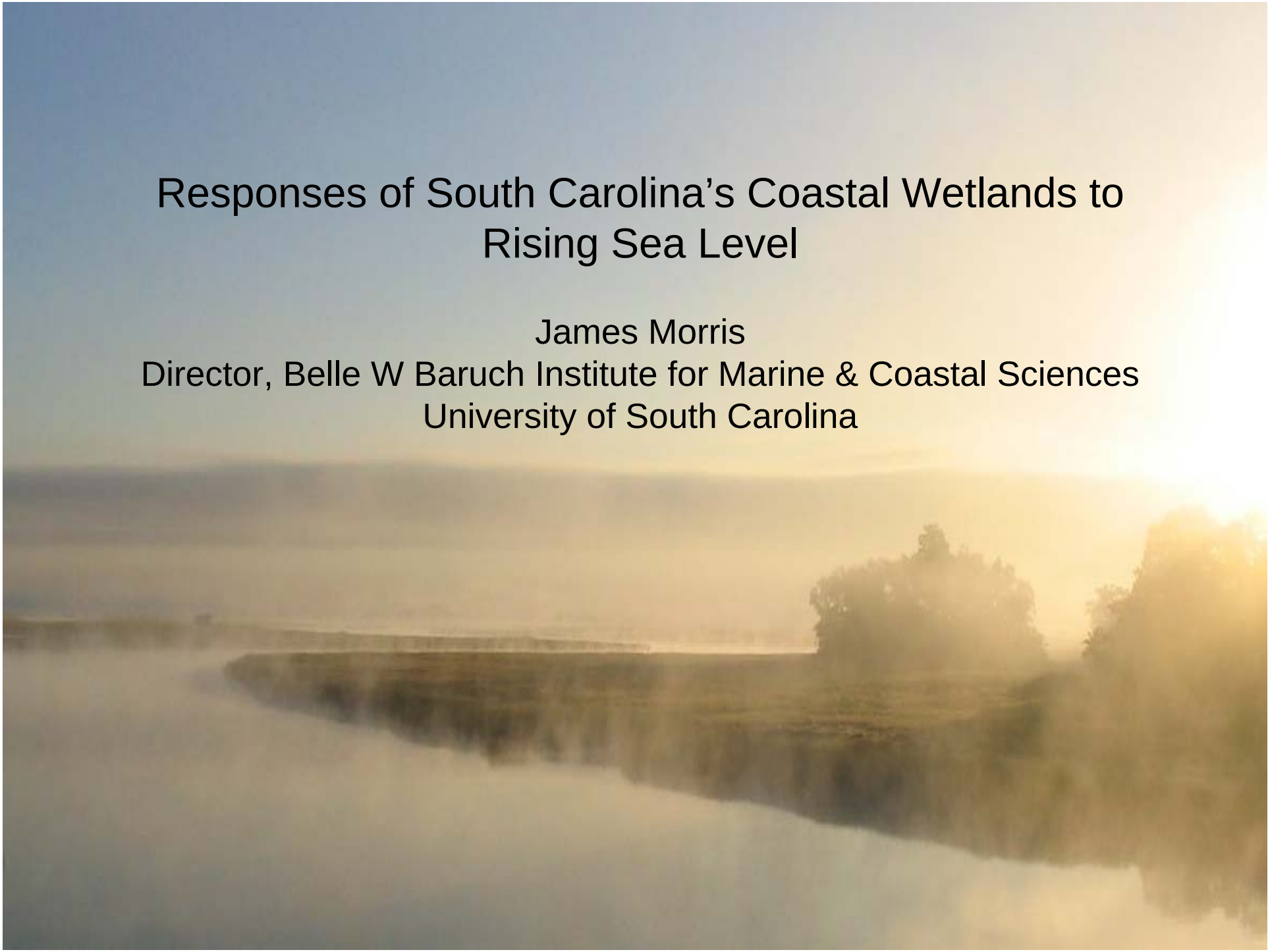

Responses of South Carolina's Coastal Wetlands to Rising Sea Level

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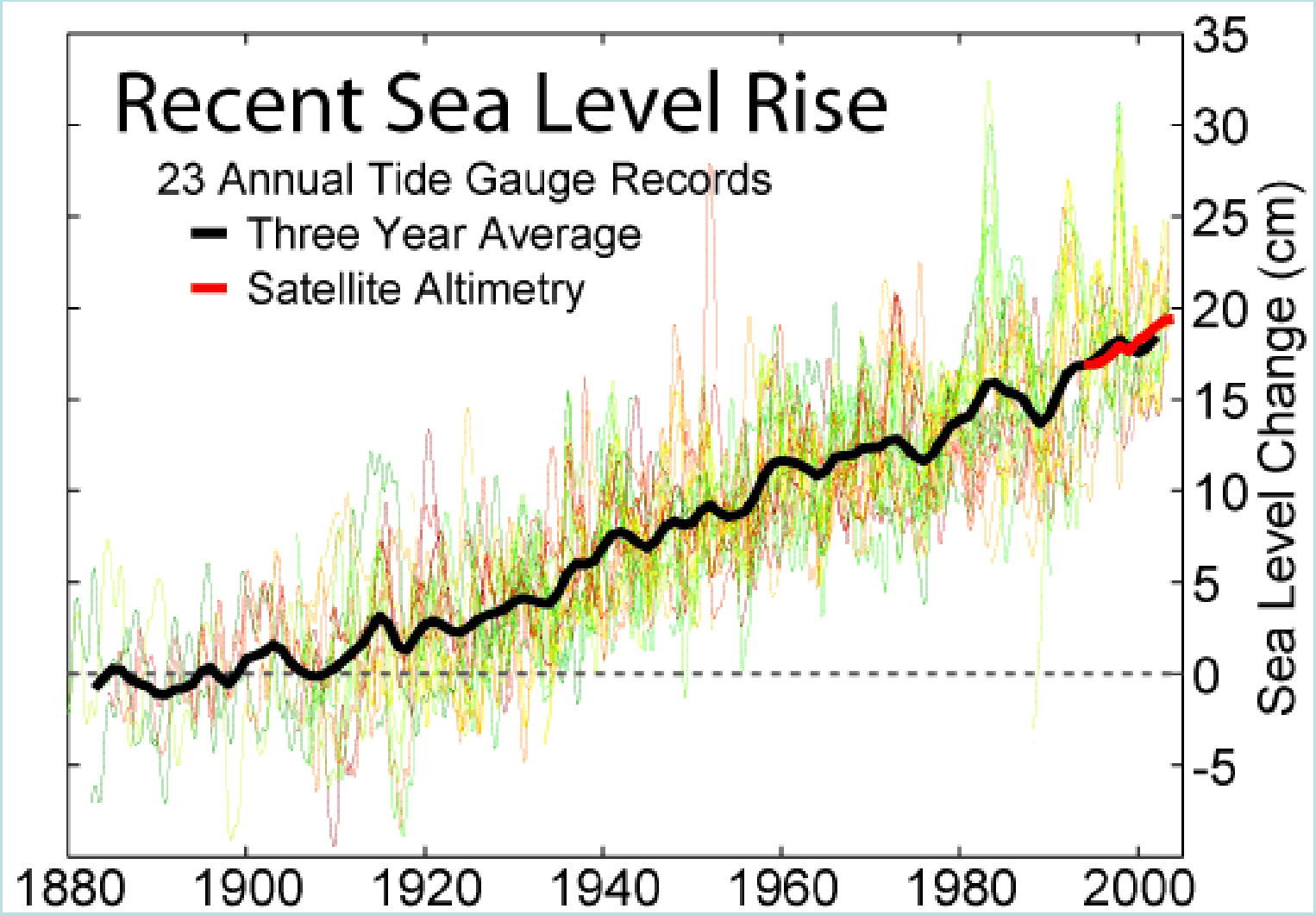
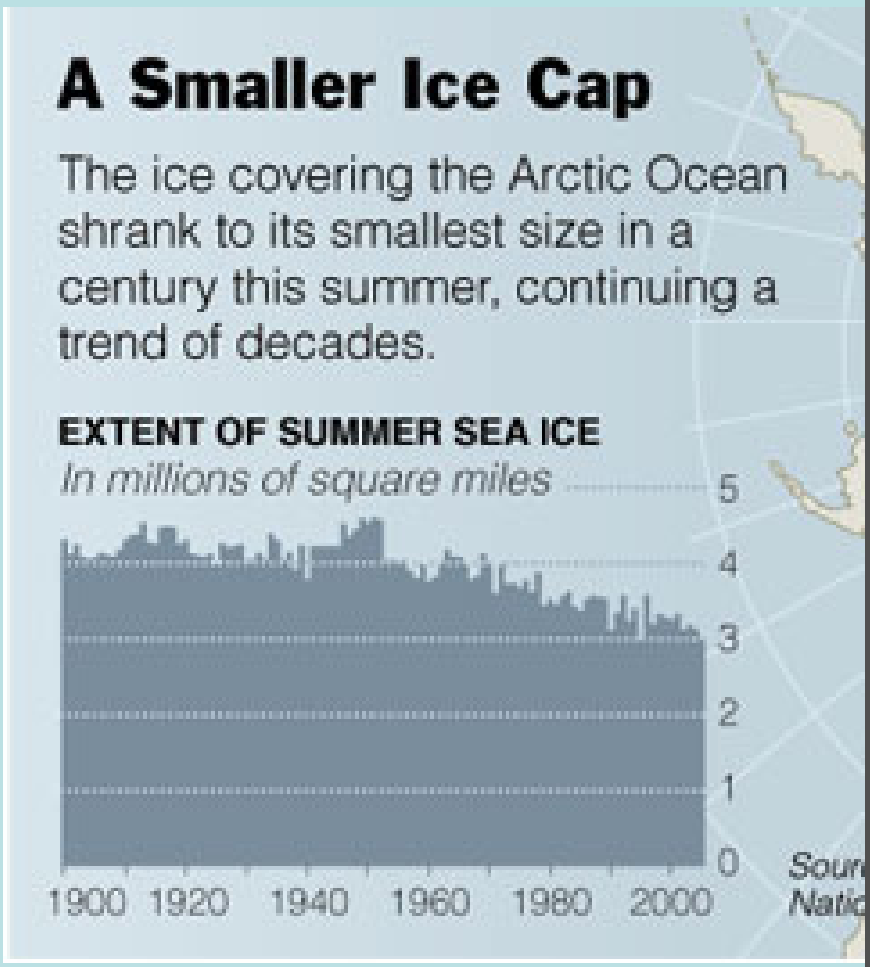
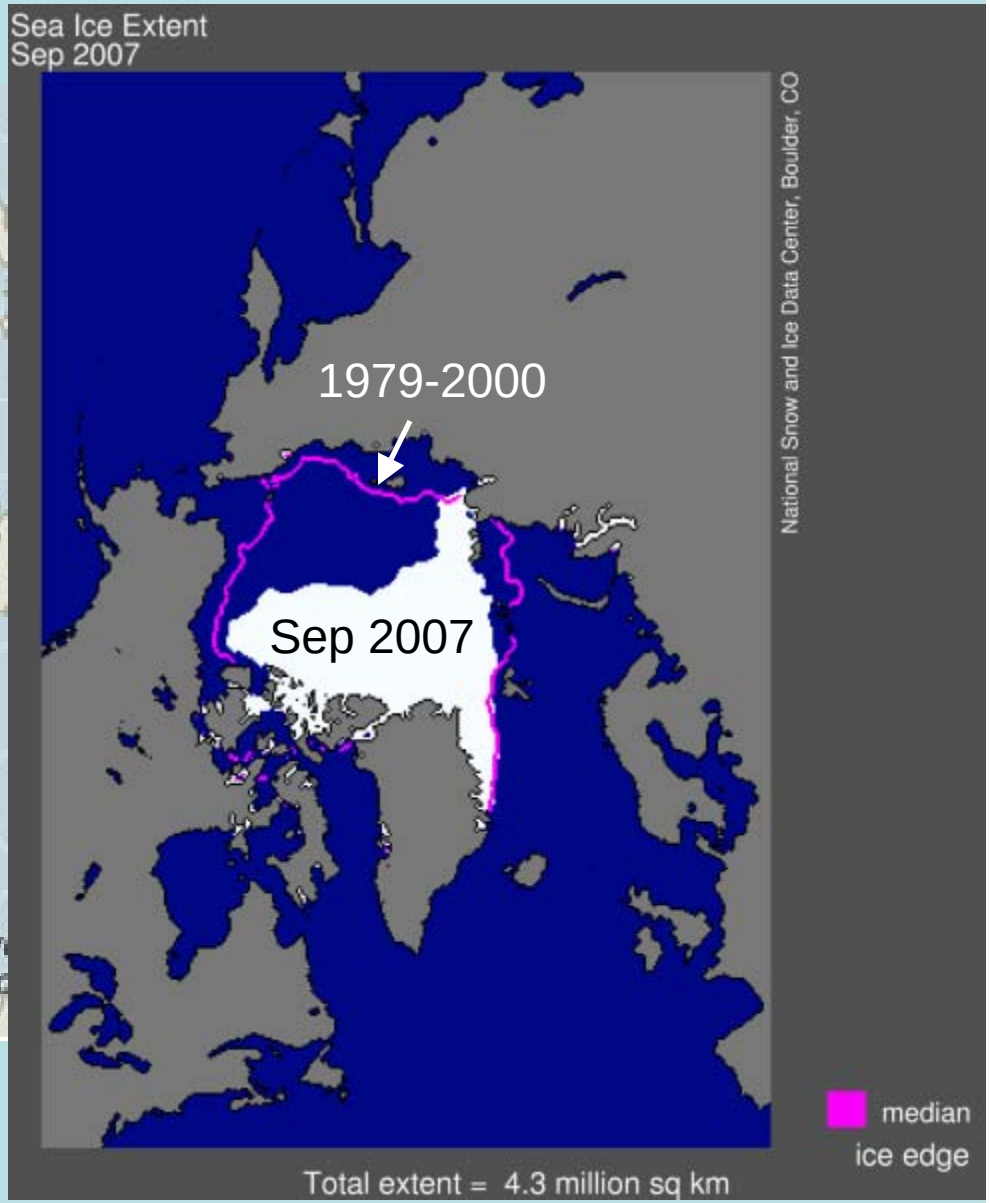
The fourth and most recent Intergovernmental Panel on Climate Change assessment predicts a sea level rise of **15 to 23 inches** by end of the 21st century, however, many feel that this estimate is conservative. Note, for example, that the observed rate of ESLR from 1993 to 2003 has already exceeded the lower limit predicted by the fourth IPCC assessment. Rhamstorf (2007) discusses the conservative nature of the IPCC reports (largely due to uncertainty surrounding the predictably of melting ice sheets). Using a semi-empirical approach he predicted a sea level rise of **20 to 55 inches (1.6 to 4.6 feet)** by the end of the 21st century. The complete melting of both the Antarctic and the Greenland ice sheet would result in a sea level rise of **70 meters (230 feet).**


Recent Sea Level Rise
23 Annual Tide Gauge Records
Three Year Average
Satellite Altimetry
35
30
25
20
15
10
5
0
-5
Sea Level Change (cm)
1880
1900
1920
1940
1960
1980
2000

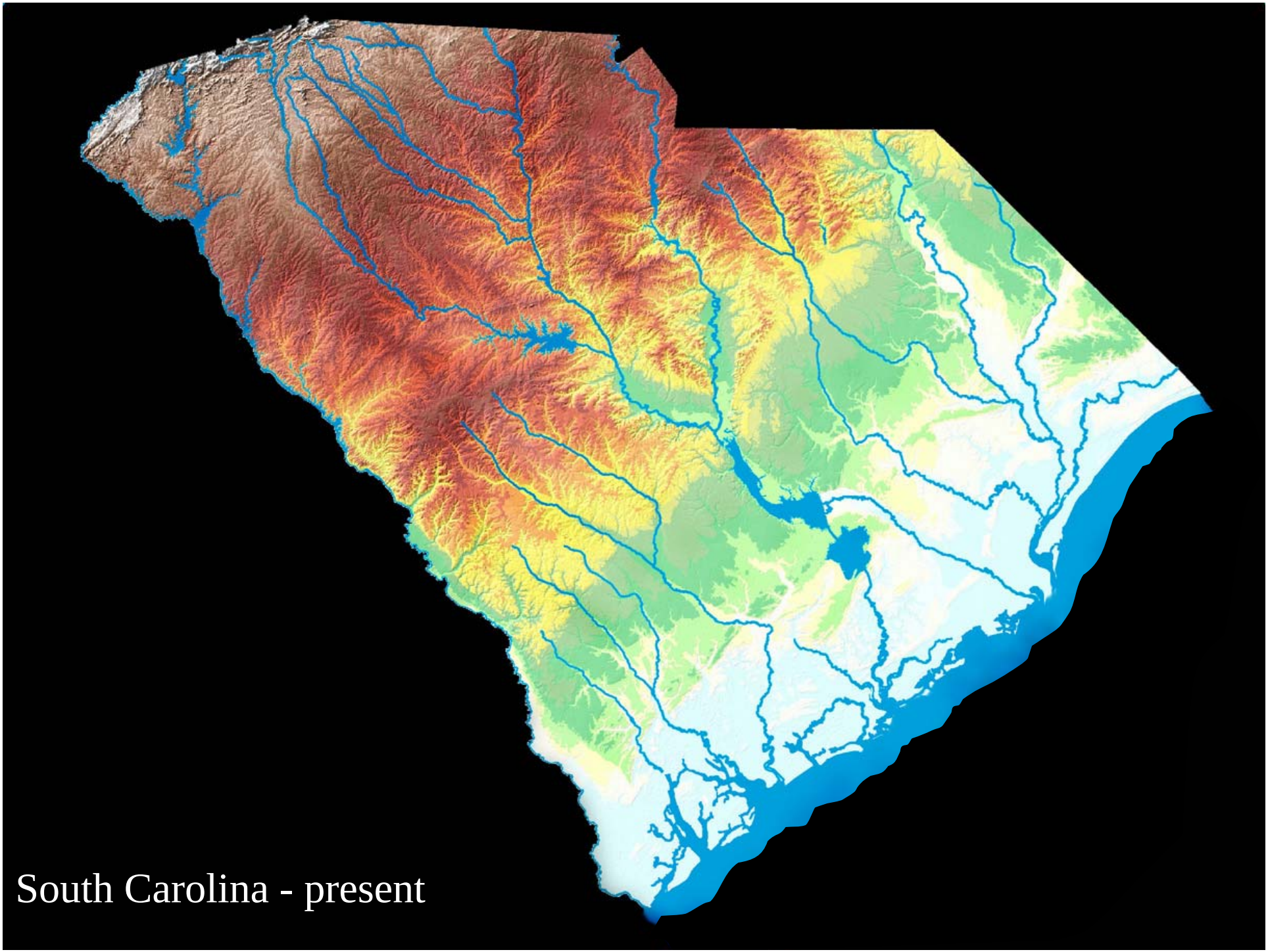


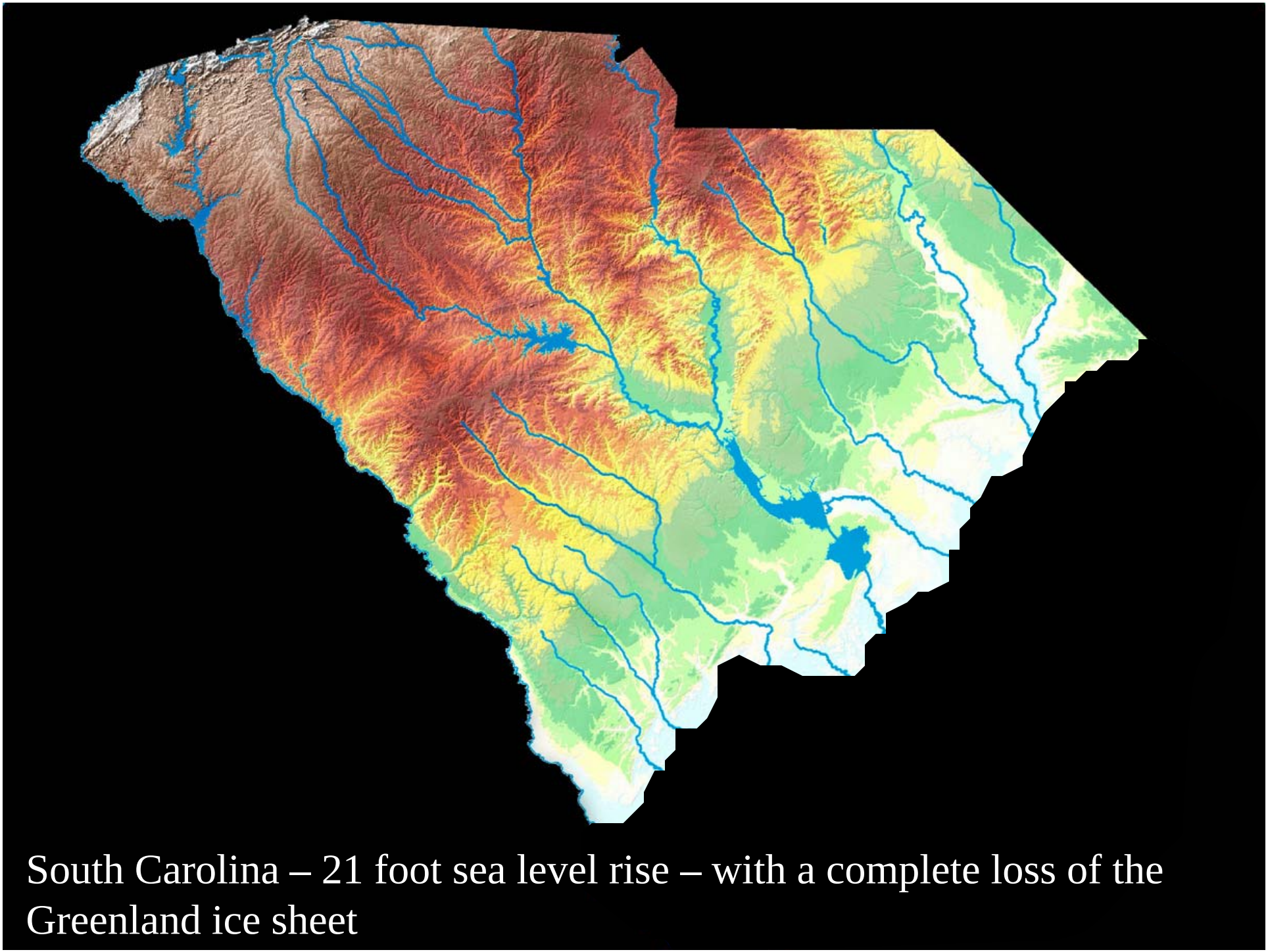


Source: National Snow and Ice Data Center

If the Antarctic and Greenland ice sheets melted, cities as far inland as St. Louis would be inundated

Melting of just the Greenland Ice Sheet would drown most coastal cities up to **7 m (23 feet)** above modern sea level. Note that this is the equivalent of 7 cm/year rise if realized in 100 yr.


South Carolina - present



South Carolina – 21 foot sea level rise – with a complete loss of the Greenland ice sheet

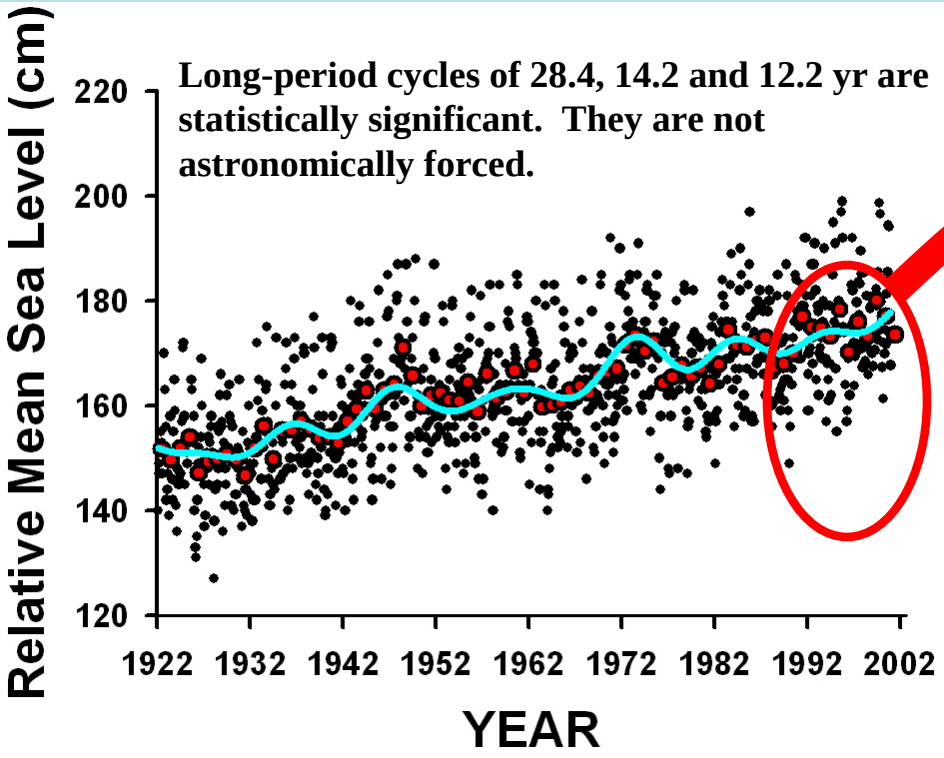
Paleoclimate information supports the interpretation that the warmth of the last half century is unusual in at least the previous 1300 years. The last time the polar regions were significantly warmer than present for an extended period (about 125,000 years ago), reductions in polar ice volume led to 4 to 6 metres of sea level rise.

What is the range in possible future rates of sea-level rise?
What should we plan for?

1. **Conservative IPCC rates*** **(excluding Greenland and Antarctic): 0.23 – 0.51 cm/yr (<1/5 in/year)**

2. **Rhamstof (2007) including ice melt: 0.5 – 1.4 cm/yr (<3/5 in/year)**

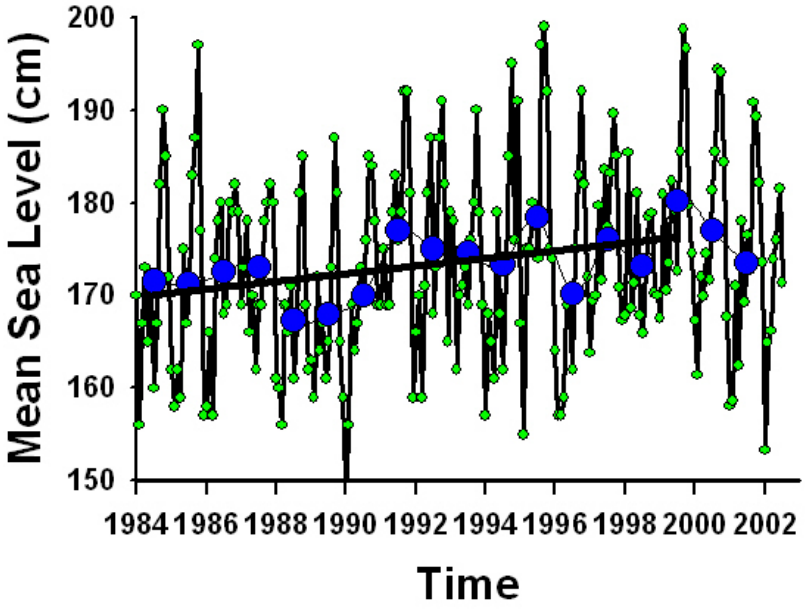
* A2 scenario (800 ppm CO_2 by 2100)



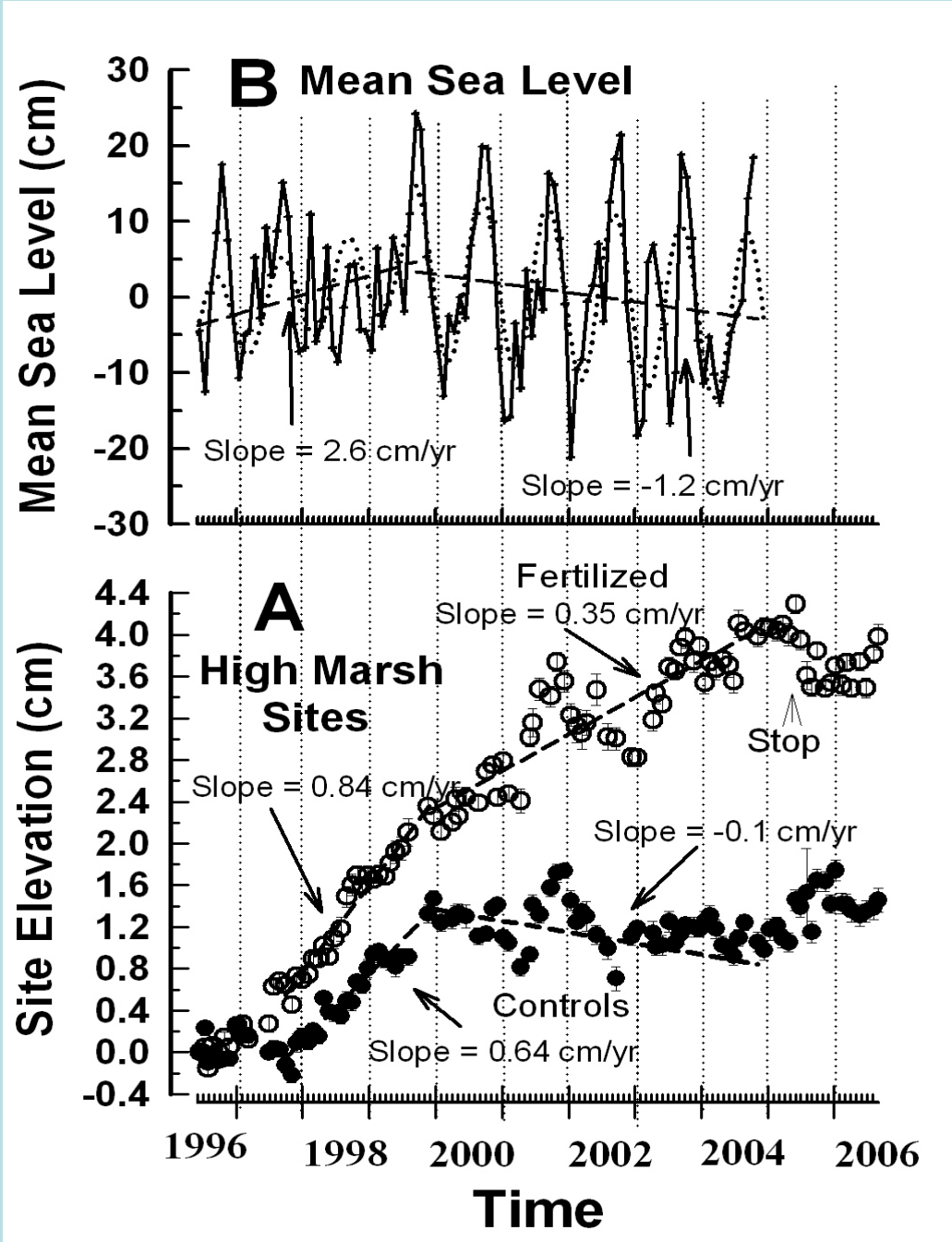
The recent rate of sea level rise (SLR) has been unusually high

1984-1999:
RSLR=0.42 cm/yr

The rate of SLR is not a constant.



Sediment-Elevation Tables (SETs) are used to monitor the elevation of the marsh surface in control and fertilized plots.



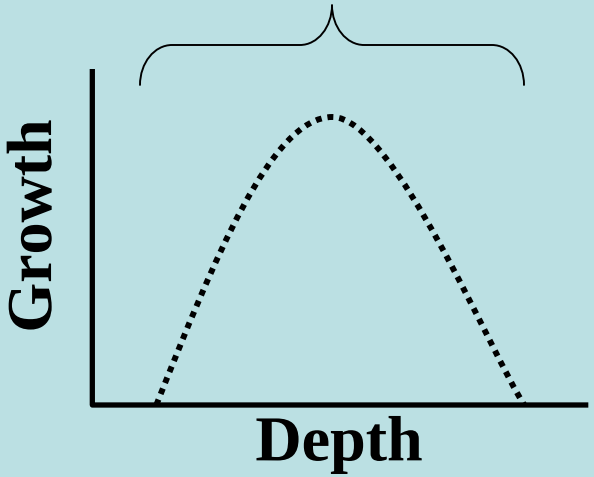
MSL changed direction in 1999/2000

Sediment accretion is a function of biomass density on the marsh surface and flood frequency & duration.

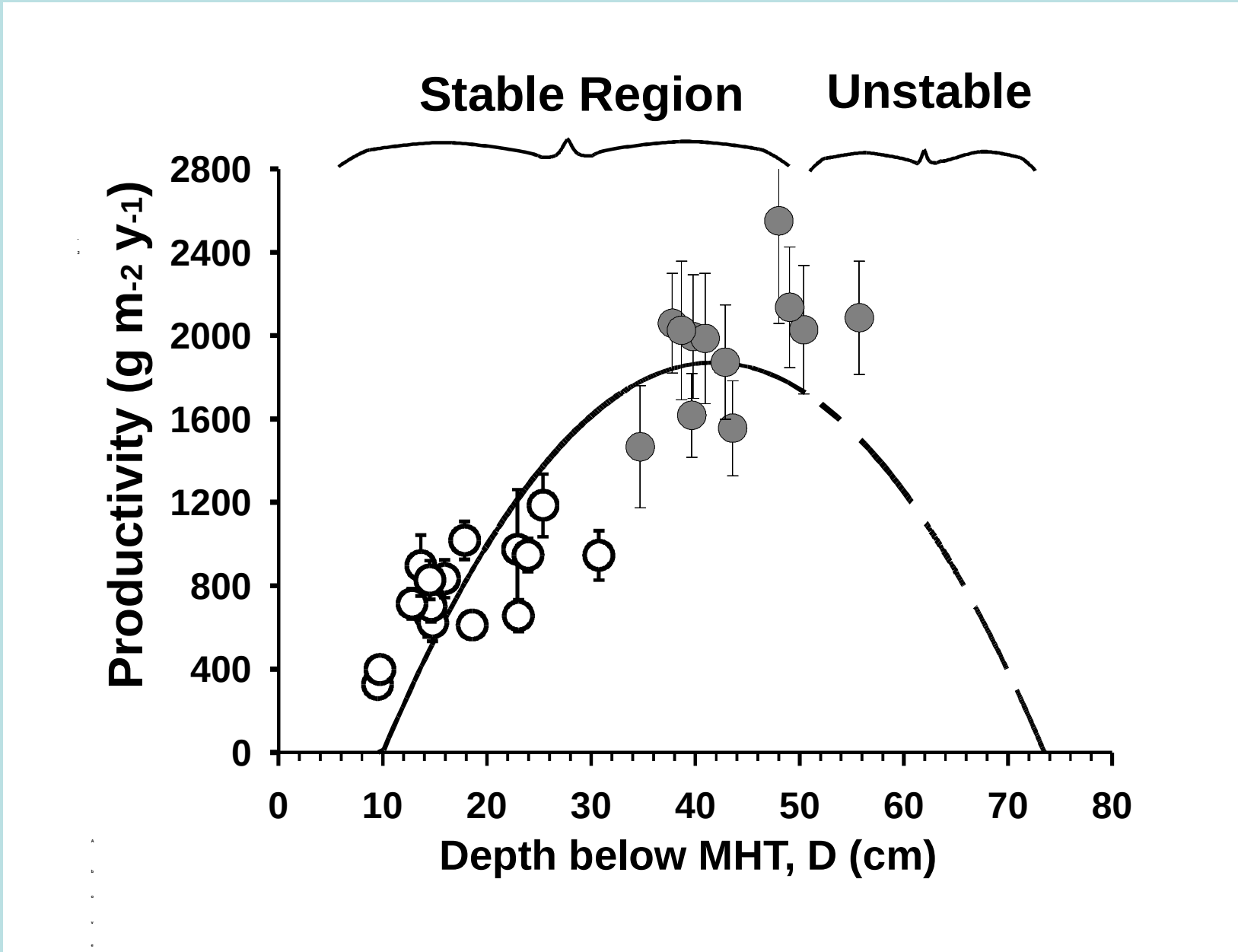
Note that the marsh was not able to keep up with the rapid rate of SLR prior to 2000. 0.8-1.0 cm/yr is probably about the limit in this area.

A natural example of

Productivity=f(depth)

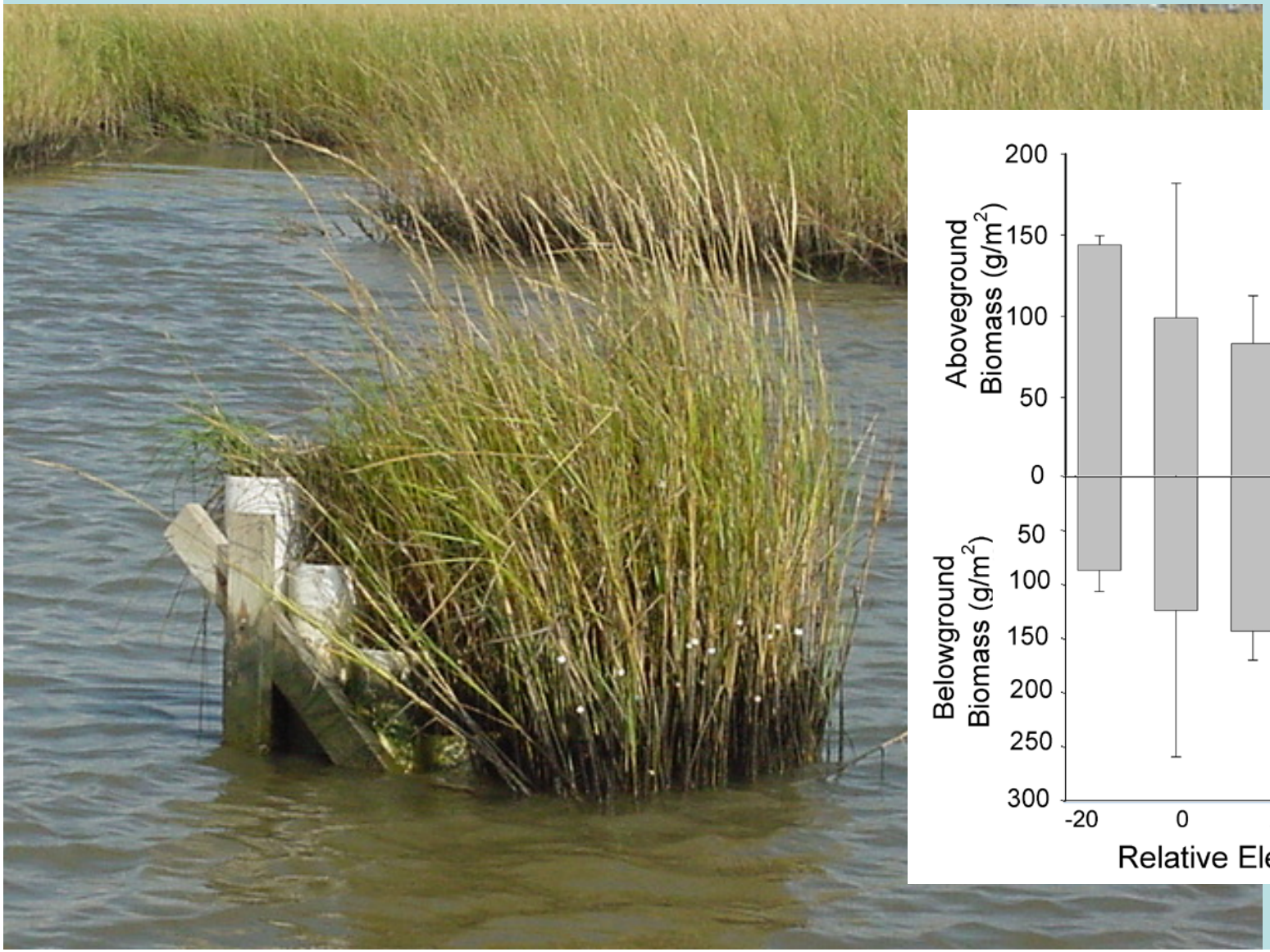


North Inlet, SC



There are a number of ways to experimentally simulate sea level rise such as the PVC planters or ‘marsh organs’ shown here.

Louisiana, October 2002



The preceding interactions are summarized by the following system of equations:

inorganic organic

$$\partial S/\partial t = (q + k_s B_s)D + k_r B_r$$ Sedimentation rate

$$B_s = aD + bD^2 + c$$ Abovegr biomass

Root:shoot ratio

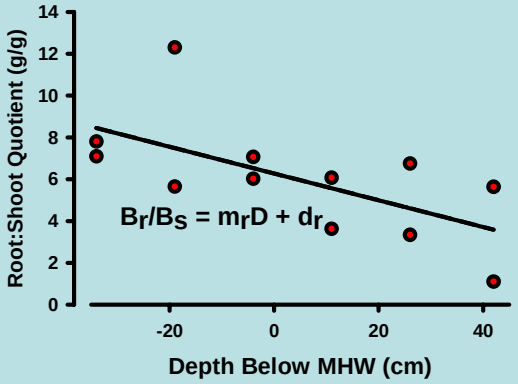
$$B_r/B_s = m_r D + d_r \; ; \quad B_r = B_s(m_r D + d_r)$$

$$B_D = \alpha - \frac{\beta k_r B_r}{(q + k_s B_s)D + k_r B_r}$$ Bulk density

$$\partial Z/\partial t = \frac{\partial S}{\partial t}\frac{1}{B_D}$$ Change in surface elevation

In equilibrium, $\partial Z/\partial t = r$ (r = rate of SLR) or:

$$r = \frac{(c[d_r k_r + D(k_s + k_r m_r)] + D\{bD(d_r k_r + Dk_s + Dk_r m_r) + a[d_r k_r + D(k_s + k_r m_r)] + q\})^2}{D(\alpha q + a\{D[\alpha k_s + k_r m_r(\alpha - \beta)] + d_r k_r(\alpha - \beta)\} + bD\{D[\alpha k_s + k_r m_r(\alpha - \beta)] + d_r k_r(\alpha - \beta)\}) + c\{D[\alpha k_s + k_r m_r(\alpha - \beta)] + d_r k_r(\alpha - \beta)\}}$$



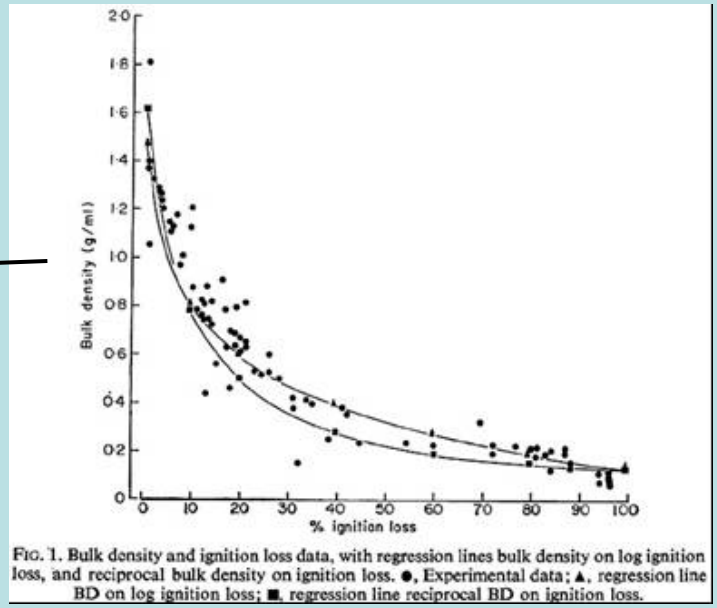


FIG. 1. Bulk density and ignition loss data, with regression lines bulk density on log ignition loss, and reciprocal bulk density on ignition loss. ●, Experimental data; ▲, regression line BD on log ignition loss; ■, regression line reciprocal BD on ignition loss.

In words: the depth of the marsh surface increases as the rate of SLR increases.

Conclusions

1. **The rate of SLR including loss of ice from Greenland and Antarctica is likely to be 0.5 – 1.4 cm/yr (Rhamstof (2007).**

2. **The current rate of SLR is about 0.3 cm/yr for the period 1993 – 2003 (Meehl et al. 2007).**

3. **Salt marshes in SC probably can accrete no more than 0.8 cm/yr.**

4. **Salt marshes will transgress (migrate) inland as sea level rises.**

5. **Given the average slope of the SC coastline (150 feet of rise over a distance of 75 miles), if the marshes accrete 0.8 cm/yr, then they will migrate a distance of 2 km or 1.2 miles in 100 years.**

Funding Sources:

NSF

NOAA

USGS science for a changing world